ELEMENTS OF RADIO CONTROL

PART 5 By HOWARD McENTEE

EXPERIMENTERS in the field of radio control work who have not had the benefit of considerable radio development work are often at a loss as to what style of antenna to use, particularly for the transmitter. As a matter of fact, for short range work. particularly where the transmitter has reasonable power output, almost any sort of "sky wire" will do, if it is properly tuned to the frequency in use. As the control range is increased, however, or transmitter power is reduced, it becomes imperative to use the most efficient radiating system possible.

Without going into too much technical detail we will cover here a few of the salient points of simple radiating systems suited to this work.

There are several things to be considered; one of the first of which is that many antennas do not radiate a signal of equal strength in all directions. Most horizontal radiators, for example, put out considerably more energy broadside; that is, at right angles to the length of the wire, than they do off the ends. In most cases the range is short enough and sufficient power is available to make this characteristic of minor importance, but it is one that should be kept in mind.

Another of these odd facts is that maximum transfer of energy from transmitting to receiving antenna takes place when both are in the same plane, the latter term referring of course to the position in which each is placed. For example, a transmitting antenna which runs parallel to the earth works best with a receiving antenna which is also horizontal. On the other hand, vertical transmitting and receiving antennas work well together. Here again the effect is not of great consequence in most cases in which radio control equipment is employed, but it is something to consider when the utmost efficiency is desired. This orientation of an antenna is usually called "polarization" and the two main classifications, horizontal and vertical polarization, are self-explanatory.

As a matter of fact practically all receiving antennas in this work are horizontal since they run lengthwise of fuselage or wings in most cases.

Now that a few elementary points have been covered, let us see what can be used that is simple and efficient. By far the simplest and most convenient antenna for transmission on the ultra high frequency bands such as we employ, is the so-called half-wave vertical. As the name implies, this is about 1/2 wave high (around 8 feet for the 5 meter band) and is usually in the form of a telescoping rod of several sections, the lower end of which fastens directly upon the transmitter by means of stand-off insulators. Such an antenna is self-supporting, requiring no pole or guy wires and can be put in place in a few seconds. In actual use the lower end is usually connected to the plate coil of the transmitter by means of a clip, and a variable condenser is inserted in the lead, both to keep the high-voltage off the antenna and to aid in adjusting the load properly. This form of antenna is shown in Fig. 1A.

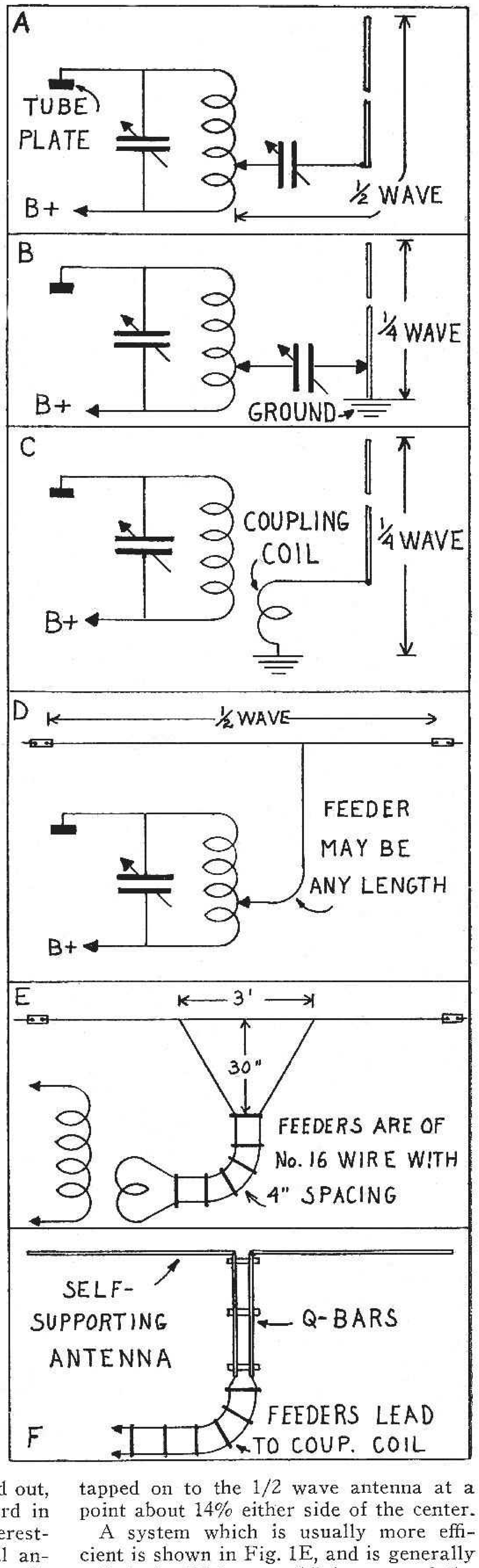
An even more convenient style is the quarter wave vertical, which, as might be expected, is only 1/4 wave high. This can also be fed by a tap on the plate coil, but the feeder wire must be tapped onto the antenna about 14% up from the lower end. The bottom of the antenna must be fastened to a ground point; the transmitter chassis will do in most cases, particularly if the transmitter is placed on the ground. Such an antenna system is shown in Fig. 1B. Another way of feeding this style antenna is shown in Fig. 1C. Here the lower end is connected to a coil of several turns which is placed in inductive relation to the plate tank of the transmitter. Coupling is then varied by shifting the position of the small coil relative to the large. Either of these coupling systems will give good results when properly tuned, but the latter is usually more convenient.

The reader will doubtless wonder why such emphasis has been given to vertical antennas when as mentioned previously most radio control receiving antennas are horizontal. The answer lies simply in the fact that over short ranges the discrepancy is not bothersome, particularly since there is usually power to spare. Moreover, as pointed out, these vertical types are the last word in simplicity and convenience. An interesting point in passing is that vertical antennas transmit energy practically equally in all directions—they are not directional.

Horizontal antennas are usually used when the radiator will be at some distance from the transmitter. A popular type is shown in Fig. 1D, and is known as the single-wire-feed system. The feeder is connected to the plate coil as in Fig. 1B, but may run any reasonable length, and is tapped on to the 1/2 wave antenna at a point about 14% either side of the center.

A system which is usually more efficient is shown in Fig. 1E, and is generally called the "delta match" because of the triangle formed where the feeders join the antenna. This feed system is preferably used with a push-pull output stage, so that the coupling coil may be placed between the two halves of the plate tank to form a perfectly balanced arrangement. The feeders are tapped on both sides of

(Continued on page 48)



two years ago in the navy XF4F-1 version as a carrier fighter. However, under present war conditions in which the British Fleet is anchored out to sea and is not actively participating in the Battle for Britain, the Fleet Air Arm has been functioning as an adjunct of the Royal Air Force and its duties have consisted mainly of spotting, reconnaissance and patrol. Undoubtedly, the Grumman G-36A will be used as a defending fighter at navy bases and shore stations. These military objections have come in for far more than their share of activity through the course of the last few months and it appears likely that the Grumman G-36A will see plenty of action and much will be heard from it.

Elements of Radio Control

(Continued from page 11)

center, and the feeders must be made of a definite size of wire with measured spacing between them for proper results. The data given in Fig. 1E show only one set of conditions; there are many other combinations of wire size and spacing possible. The reader is referred to the "QST" or "Radio" amateur manuals for data on other wire spacings and such details.

The feeder spreaders may be made of most any insulating medium, but wooden dowelling soaked in hot parafin is a cheap and easily available material. The spacing is 4" between wires and No. 16 wire should be used.

In most partable installations, the antenna is mounted fairly close to the transmitter and high enough to clear nearby objects such as people, autos, etc. Thus the feeders need not be very long; however, those shown in Fig. 1E may be any length up to several hundred feet with very little loss.

The same style of feeders is employed with the final antenna design we shall cover, the so-called "Johnson Q," seen in Fig. 1F. The "Q" part really refers to the method of matching the open wire line to the antenna proper, and if the arrangement is properly set up very high efficiency may be had. It is preferable to buy a ready-made kit for such an antenna as all insulators and antenna parts are included with very complete instructions. The antenna and "Q" bars are of aluminum tubing hence self-supporting, so that only a single pole is required.

This covers most of the popular and simple transmitting antennas. As pointed out, the verticals are by far the most convenient, as they may be fastened directly to the transmitter with no feeders or supporting poles required. The horizontals, on the other hand, are as a rule a bit more efficient. The latter may also be made of telescoping aluminum tube so that they may be quickly erected with a single light pole.

The length of so-called "half-wave" antennas is in reality a trifle less than a true half-wave and is calculated from the formula $L = \frac{467.4,}{fmc}$ where L equals length in feet, and fmc equals frequency in megacycles. For operation on the 5 meter or 56 mc. band, an antenna cut for 58 mc. will work reasonably well over the entire band.

As a matter of fact, antenna length is not a cut and dried figure, but varies with many factors, including height above ground, type of feed system, character of any objects fairly close to the antenna (such as trees, metal roofs, wires, etc.) and other factors. Thus it is best to adjust the antenna individually for proper length, after having cut it to the theoretical length as described above.

Those vertical antennas which are fastened directly to the transmitter are particularly susceptible to this variation in length; most horizontal antennas are erected fairly well in the clear, and 10 feet or more above ground, and can be used successfully when cut to the theoretically correct length.

One simple means for determining the exact length of vertical antennas is simply by observation of the plate current meter while the antenna length is varied. Starting with the theoretical length, increase a few inches at a time and note the plate meter reading. Also try decreasing the length by small steps; the proper length may be noted at the point that gives the highest plate current reading. While following this procedure, the plate current will sometimes rise above the rated value for the tube in use. In such a case it should be lowered to the rated value by decreasing coupling; in the systems of Fig. 1A, 1B, and 1D this is accomplished by reducing the condenser capacity or moving the tap further from the plate or "hot" end of the coil; in Fig. 1C, 1E, and 1F the coupling coil should be shifted away from the "hot" end or simply moved slightly sideways out of the inductive field.

A good way to adjust the transmitter and antenna system for maximum is to use the radio control receiver as an indicator. A low reading milliammeter in the plate circuit allows the operation to be carefully checked. The receiver must of course be placed at a good distance from the transmitter, preferably 500 feet or more, with an assistant to check meter readings and signal back the results. Highest transmitter efficiency is of course indicated by lowest receiver plate current for receivers using the type RK62 tube. Changes at the transmitter will cause corresponding shifts in its plate current; the antenna coupling should be adjusted after each change to keep the plate current at a constant value, so that readings at the receiver end may be properly interpreted.

We might remark in passing that most experienced amateur radio men usually have decided preferences in antenna systems and for this reason will probably pass over the foregoing rather rapidly. It has been written however for the beginners, many of whom have gotten their amateur licenses primarily for radio control experimentation. It is indeed toward this class of reader that a good deal of the material presented in this series has been and will be directed. For the same reason duplicate equipment of various types has been described; thus, from the several transmitters mentioned, the inexperienced can find one that fits his means and requirements.

Most model builders construct their plane first and test it thoroughly to remove all possible "bugs" before installing the radio control equipment. This is probably the ideal procedure, but even so it seems we may be overlooking a good bet in not using radio control as an *aid* in preliminary trials of a new model.

To be of any real benefit, it would probably be imperative to have at least two channel control, operating the motor speed and the rudder.

The trials should be conducted on a large level surface, possibly a flat open field, a body of water, or even a frozen surface. It is naturally necessary to have the control equipment in top condition, so it should be thoroughly tested at the maximum distance from the transmitter and with the gas engine running full speed. The model can easily be staked down so that it can't make a premature take-off.

When the radio control is working to full satisfaction, the model may be allowed to taxi over the surface at gradually increasing speeds until it has just enough velocity to take off and "hedge-hop." Naturally a continuously variable motor speed control would be ideal for this work. If a two step control, as described in Part III, is used the two speeds will have to be increased manually between each test run until the lower speed will taxi the model just under take-off conditions, while the higher R.P.M. will just lift it off.

The possibilities of such a system appear almost limitless and of course this is the exact procedure followed in large airplane practice, where the pilot first taxis over the field to get the "feel" of the ship before attempting full flight.